Infaunal Analysis

In order to characterize macrofaunal communities at the 24, 44, 47, 640, 770, 795 and 885m stations, the ROV was used to collect samples of seafloor sediments with 7.5 cm diameter push cores (0.0044 m^2). Cores collected from each station were spaced approximately five meters apart. Sediment from the top 5 cm of the core was washed gently through a 0.3 mm mesh sieve using cold seawater. Macrofauna at the 60, 90, 325 and 450 m stations were collected with a Smith-McIntyre grab. This is a common grab sampler for collecting quantitative seafloor samples (Lie, 1970), which was lowered from the ship to the seafloor on a cable. The grab collects 0.1 m^2 of bottom sediments to a depth of ~10 cm.

Epifaunal Analysis

Video footage was annotated and analyzed to assess megafaunal communities present on the seafloor along the proposed route. Megafauna are defined as epifaunal animals large enough to be seen on video recordings, a distinction that provides almost no overlap with the macrofauna portion of the study. All available video footage was annotated using MBARI's computer annotation application Video Information Capture with Knowledge Inferencing (VICKI). Video transects surrounding sampling stations were annotated quantitatively.

ROV Surveys of Megafaunal Abundance

Taxonomic identification was performed to the lowest practical taxonomic level. To assess the patchiness and dispersion of megafauna, transects at each station were subdivided into 25 m subsections, which were considered as replicate sample units. The length of replicates was determined using several criteria: 1) maximizing the number of replicates within each transect, 2) minimizing the number of replicates with zero taxa, and 3) choosing a replicate size above the resolution of ROV navigation. Organisms were grouped into major taxonomic groups, within which the abundance and number of lesser taxa were determined for each 25m replicate along each transect. The mean and variance of the number and abundance of taxa were determined for each major group along each transect.

6.2 Results and Interpretation

Infaunal Analysis

A total of 67 push cores and nine Smith-McIntyre grab samples were collected. Polychaete worms were the dominant group both in abundance and taxa richness at most depths. Abundant polychaetes included *Magelona hartmanae, M. sacculata and Scoletoma luti* (25 m), *Chaetozone lunula, Aricidea (Acmira) catherinae,* and *Mediomastus* spp. (44 m), *A. catherinae* (47 m), *Sternaspis nr. fossor* (60 m), *Mediomastus* spp. and *Spiophanes berkeleyorum* (90 m), *Sphaerosyllis ranunculus* (325 m), *Onuphidae* spp., *Protodorvillea gracilis* and *S. ranunculus* (450 m) and *Cossura pygodactylata* (885 m). Oligochaetes dominated at the 885 m station. Gammarid amphipods were the most abundant organism at the 640 m (*Ampelisca unsocalae, Lepidepecreum serraculum* and *Tiron biocellata*), 770m (*A. unsocalae, Photis typhlops* and *Byblis barbarensis*), and 795 m (L. *serraculum* and *A. unsocalae*) stations. Gammarids were relatively abundant (one the top five most abundant taxonomic groups of animals) at all stations. Other relatively abundant animals include Bivalves (44, 47, 60, 90, 640 m), Nemertea (44, 47 m), Ostracods (44, 47, 325 m), and Ophuroids (60, 90, 450 m). Caprellids (*Tritella tenuissima*) and Tanaids were abundant at the 325 and 450 m stations. Taxa diversity for Gastropods was relatively high at the 60, and 90 m stations, and for Ophuroids at 90 and 325 m. Isopods and Tanaids were diverse at 325 m.

Benthic Megafaunal Analysis

MBARI surveyed 55.2 km of benthic habitat during this investigation. Some of the 52.9 km proposed MARS cable route was overlapped during 10 ROV dives; 76 percent of the 52.9 km route was observed. Thirty-nine hours of video footage were annotated and analyzed.

Some species were not represented in quantitative video samples. There was a gradient in the distribution and abundance of benthic megafauna from the shallow, energetic (sand ripples) stations dominated by mobile megafauna and accumulations of drift kelp and other debris, to less physically disturbed (by wave action) sites on the continental shelf (60 – 139 m) that included higher densities of sessile sediment-dwelling megafaunal invertebrates, notably the seapens *Ptilosarcus* and *Pennatula.*

Due apparently to chronically higher rates of erosion, the substratum on continental shelf break and upper slope are often rock outcrops, which house a variety of sessile invertebrates and serve as physical structure favored by various mobile fishes and invertebrates. Sedimentary substratum returns deeper (>450 m) on the continental slope where seapens once again are conspicuous members of the benthos, which also includes a variety of anemones and holothurians. The relative abundance of fishes declines with depth, as invertebrates become more abundant.

Between 10-24 m, there was poor visibility and a rippled sand bottom, with large areas with shell hash, sparse drift kelp and no visible fauna. Other areas in this depth range included patchy accumulations of brown, green and red algae with occasional *Cancer* crabs, seastars, polychaete worms (*Diopatra ornata*), and small flatfish (*Citharichthys* spp.). Structures at the Kaiser (National Refractories) outfall (12.5 m water depth) and the Duke Energy outfall (18.7 m water depth) supported communities of the small corallimorph *Corynactis californica* and large anemones (*Metridium farcimen)*. At 25-39 m, sand with drift kelp and gastropods were the dominant seafloor features, plus sparse sea pens, flatfish, seastars and drifting eel grass. Between 40 and 59 m there were abundant Ceriantharid anemones, flatfish (*Citharichthys* spp.), the seastar *Luidia foliolata* and the seapen *Stylatula elongata;* the substrate here was silty mud with fine grain sand. From 60 to 139 m, *S. elongata,* and the seastar *Rathbunaster californicus* were very abundant. The anemone *Metridium farcimen,* flatfish, seapens *Ptilosarcus gurneyi* and *Pennatula sp*. were also common. There are occasional scoured surfaces and occasional rock outcrops. At 140-200 m *R. californicus* was the dominant organism. few species of rockfish, flatfish and holothurians were present, but not abundant. Shell hash was locally dense in some areas between 175-191 m. Rock outcrops became more prevalent from 280-449 m and the substrate surface appeared eroded at around 425m. *Allocentrotus fragilis* (urchin), *Merluccius productus* (Pacific Whiting), and *R. californicus* were very abundant. Other species associated with hard substrates (rockfish, sponges, anemones, holothurians, and crinoids) were also present in high numbers. There were numerous rays (primarily *Raja rhina*), catsharks, and several species of flatfish. There was a large aggregation of hermit crabs at 474 m. From 450-599 m the seapen *Halipteris californica* was the dominant organism. The *Liponema brevicornis* (an anemone), *M. productus* and the flatfish *Microstomus pacificus* were also present in high abundance. At depths over 600 m seapens *H. californica*, and *Umbellula lindahli* dominated. The crab *Chionoecetes tanneri*, the rockfish *Sebastolobus*, gastropods and small Mesomyarian anemones were very common.

Quantitative Transects

Within the ROV survey areas, MBARI analyzed 10 quantitative transects ranging from 250 to 1675 m. The total footage covered 7,825 m of benthic habitat. Quantitative transects were not possible at 25 m due to low visibility. Seapens (*Pennatulacea*) were the most abundant and most species diverse megafaunal organism on the proposed MARS cable route. A dense assemblage of *H. californica* was present at 885 m; this species was also very abundant at the 640 and 795 m stations. *U. lindahli* was very abundant at all stations from 640 to 885 m. In shallower water (47, 60 and 90m), *S. elongata* was present in high numbers. Other relatively abundant organisms (top five most abundant taxa) included gastropods (44, 47 and 450 m), ceriantharids (47, 450, and 640 m), *R. californicus* and *A. fragilis* (325 m), the anemone *Liponema brevicornis* (450 m), *Sebastolobus*, *C. tanneri* (640, 795 m) and the holothurian *Pannychia moseleyi* (885 m). Sponges (Porifera) were only found on hard substrates from 90 to 450 m. Anemones (Actinaria) were observed at most stations as were crabs (Brachyura), and seastars (Asteroidea). Corallimorphs were found primarily at deeper depths.

Due to poor visibility, none of the fishes at the 44 m station were identifiable to species. Pleuronectiformes (unidentifiable flatfish) and flatfish from the families Bothidae and Pleuronectidae) were found at all stations. Bothids were most abundant at the 60 and 90 m. Hagfish (Myxinidae) were consistently present from 450 to 885 m. Sebastolobus (Scorpaenidae) was present from 640 to 885 m. Zoarcids were represented at all stations from 325 to 885 m. The highest total megafaunal abundance/m was at the 885 m station and 325 m stations, where invertebrates taxa (mainly seapens) accounted for the majority of the megafauna observed. The richness of megafaunal taxa was greater at mid depths for both invertebrates and demersal fishes, with the highest diversity at the 325 m stations. A higher number of invertebrate taxa were present at all depths except at the 60 m station where more species of demersal fish were present.

Summary and Discussion

A total of 39 hours of video, 67 push cores and nine Smith-McIntyre grabs were collected from 11 stations. A cumulative distance of 55.2 km of seafloor was surveyed at least once. Seventy-six percent (40.2 km) of the 52.9 proposed MARS cable route was observed.

Polychaete worms were the most abundant and species diverse group of infaunal organism. Seapens were present on a large portion of the route and we found in high density in many areas. Most of the fauna on the cable route are sedentary or functionally sedentary (i.e. very limited mobility). There are large numbers of suspension and filter feeders. Avoidance of the ROV by some invertebrates and especially fishes may have led to a conservative bias for taxa richness, while attraction to the ROV lights may have overrepresented it. Adams et al. (1995) found that Pacific whiting (*Merluccius productus*) was strongly attracted to an ROV while sablefish (*Anopoloma fimbria*) and catsharks (Scyliorhinidae) showed a strong avoidance response. All three of these fishes were represented in our study.

7 Potential for EFH Adverse Impacts

This document addresses potential impacts to essential fish habitat (EFH) within California state waters (shore to 3 nautical miles) and to the outer limit of the Exclusive Economic Zone (EEZ; ~200 nautical miles). The geographic scope will facilitate consistency with permitting requirements of the California Coastal Commission (CCC) and the U.S. Army Corps of Engineers (USACE).

For the Pacific region, EFH has been identified for 89 species (Table 7-1) covered by three fishery management plans (Coastal Pelagics FMP, Pacific Salmon FMP, and Pacific Groundfish FMP) under the auspices of the Pacific Fishery Management Council. The ecologically diverse area encompassed by identified EFH includes those essential for fish spawning, breeding, feeding, or growth to maturity. The maintenance of a healthy and viable benthic community is recognized as critical to supporting most, if not all, of the life history requirements previously mentioned. This biological impact assessment for the proposed project focuses on determination of long and short-term impacts to benthic communities, with an understanding that significant impacts to these communities may cause adverse effects to fishery communities which are dependent on those resources.

Table 7-1 Fishery Management Plans and managed Species or Species Complexes for the Pacific Region

Coastal Pelagics FMP
Northern anchovy - *Engraulis mordax*
Pacific sardine - *Sardinops sagax*
Pacific (chub) mackerel - *Scomber japonicus*
Jack mackerel - *Trachurus symmetricus*
Market squid - *Loligo opalescens*
Pacific Salmon FMP
Chinook salmon – *Oncorhynchus tshawytscha*
Coho salmon - *Oncorhynchus kisutch*
Pink salmon - *Oncorhynchus gorbuscha*

Table 7-1 Fishery Management Plans and managed Species or Species Complexes for the Pacific Region

Pacific Groundfish FMP
Butter sole - *Isopsetta isolepis*
Curlfin sole - *Pleuronichthys decurrens*
Dover sole - *Microstomus pacificus*
English sole - *Parophrys vetulus*
Flathead sole - *Hippoglossoides elassodon*
Pacific sanddab - *Citharichthys sordidus*
Petrale sole - *Eopsetta jordani*
Rex sole - *Glyptocephalus zachirus*
Rock sole - *Lepidopsetta bilineata*
Sand sole - *Psettichthys melanostictus*
Starry flounder - *Platichthys stellatus*
Arrowtooth flounder - *Atheresthes stomias*
Ratfish - *Hydrolagus colliei*
Finescale (Mora) codling - *Antimora microlepis*
Pacific (Roughscale) rattail - *Coryphaenoides acrolepis*
Leopard shark - *Triakis semifasciata*
Soupfin shark - *Galeorhinus galeus*
Spiny dogfish - *Squalus acanthias*
Big skate - *Raja binoculata*
Longnose skate - *Raja rhina*
Pacific ocean perch - *Sabastes alutus*
Shortbelly rockfish - *Sebastes jordani*
Widow rockfish - *Sebastes entomelas*
Aurora rockfish - *Sebastes aurora*
Bank rockfish - *Sebastes rufus*
Black rockfish - *Sebastes melenops*
Black-and-yellow rockfish - *Sebastes chrysomelas*
Blackgill rockfish - *Sebastes melanostomus*
Blue rockfish - *Sebastes mystinus*
Boccaccio - *Sebastes paucispinis*
Bronzespotted rockfish - *Sebastes gilli*
Brown rockfish - *Sebastes auriculatus*
Calico rockfish - *Sebastes dallii*
California scorpionfish - *Scorpaena guttata*
Canary rockfish - *Sebastes pinniger*
Chilipepper - *Sebastes goodei*
China rockfish - *Sebastes nebulosus*
Copper rockfish - *Sebastes caurinus*
Cowcod rockfish - *Sebastes levis*
Darkblotched rockfish - *Sebastes crameri*

Table 7-1 Fishery Management Plans and managed Species or Species Complexes for the Pacific Region

Pacific Groundfish FMP (cont.)
Flag rockfish - *Sebastes rubrivinctus*
Gopher rockfish - *Sebastes carnatus*
Grass rockfish - *Sebastes rastrelliger*
Greenblotched rockfish - *Sebastes rosenblatti*
Greenspotted rockfish - *Sebastes chloroatictus*
Greenstriped rockfish - *Sebastes elongatus*
Harlequin rockfish - *Sebastes variegatus*
Honeycomb rockfish - *Sebastes umbrosus*
Kelp rockfish - *Sebastes atrovirens*
Mexican rockfish - *Sebastes macdonaldi*
Olive rockfish - *Sebastes serranoides*
Pink rockfish - *Sebastes eos*
Quillback rockfish - *Sebastes maliger*
Tiger rockfish - *Sebastes nigrocinctus*
Treefish - *Sebastes sericeps*
Vermillion rockfish - *Sebastes miniatus*
Yelloweye rockfish - *Sebastes ruberrimus*
Yellowmouth rockfish - *Sebastes reedi*
Yellowtail rockfish - Sebastes flavidus
Longspine Thornyhead - *Sebastolobus altivelis*
Tiger rockfish - *Sebastes nigrocinctus*
Treefish - *Sebastes sericeps*
Vermillion rockfish - *Sebastes miniatus*
Yelloweye rockfish - *Sebastes ruberrimus*
Shortspine Thornyhead - *Sebastolobus alascanus*
Cabezon - *Scorpaenichthys marmoratus*
Kelp greenling - *Hexagrammas decagrammus*
Lingcod - *Ophiodon elongatus*
Yellowmouth rockfish - *Sebastes reedi*
Yellowtail rockfish - Sebastes flavidus
Longspine Thornyhead - *Sebastolobus altivelis*
Redstripe rockfish - *Sebastes proriger*
Rosethorn rockfish - *Sebastes helvomaculatus*
Rosy rockfish - *Sebastes rosaceus*
Rougheye rockfish - *Sebastes aleutianus*
Sharpchin rockfish - *Sebastes zacentrus*
Shortracker rockfish - *Sebastes borealis*
Silvergrey rockfish - *Sebastes brevispinis*
Speckled rockfish - *Sebastes ovalis*
Splitnose rockfish - *Sebastes diploproa*
Squarespot rockfish - *Sebastes hopkinsi*

Table 7-1 Fishery Management Plans and managed Species or Species Complexes for the Pacific Region

Pacific Groundfish FMP (cont)
Starry rockfish - *Sebastes constellatus*
Stripetail rockfish - *Sebastes saxicola*
Pacific cod - *Gadus macrocephalus*
Pacific whiting - *Merluccius productus*
Sablefish - *Anoplopoma fimbria*

8 Analysis of Effects

8.1 Setting

The approach used in this analysis to establish the setting and collect information to assess project impacts consists of the following steps:

1. Initial review of existing biological information. In order to determine the presence (or absence) of sensitive species and/or habitats within the project area, as well as the information developed from field surveys/reconnaissance, the following materials were reviewed:

   - Pacific Fishery Management Council Fishery Management Plans;
   - California Natural Diversity Data Base (CNDDB) search for Monterey Quad, Monterey County; and
   - Environmental Assessment of the ATOC/Pioneer Seamount Submarine Cable (Kogan et al. 2003).

2. Consultation with local biologists. In order to verify biological information derived from the above sources, contact was made with scientists possessing specific knowledge of marine species/habitats within the project area.

Marine habitats, species of concern, and areas of concern are described in the following sections.

8.2 Marine Habitats

The primary areas of analysis for marine resources are those portions of the intertidal, subtidal, and pelagic zones that constitute the project area and are considered EFH for groundfish, coastal pelagic species, and salmon. Emphasis is given to these areas along the cable burial route.

Intertidal Zone

The intertidal zone is the area affected by tidal flows and wave action. Near the shore landing alternatives, the areas consist primarily of sandy, rockless substrate. Sand is a difficult substrate to occupy and few species do so successfully. Invertebrates that inhabit the sandy intertidal area regions have evolved such adaptive features as thick shells, sand-filtering papillae and burrowing mechanisms rather than the strong attachment devices of rocky intertidal species. Sandy beaches also provide foraging habitat for shorebirds, especially gulls, sandpipers, and plovers.

Common invertebrates of the upper intertidal area are various species of amphipods (genus *Orchestoidea)*; the predatory isopod, *Excirolana chiltoni*; and various species of polychaetes, such as *Euzonus mucronata* and *Hemipodus borealis*. The middle intertidal area is characterized by species such as the sand crab, *Emerita analoga*, and the polychaete, *Nephtys californiensis*. The sand crab is generally the most abundant of the middle intertidal organisms, often comprising over 99 percent of the individuals on a given beach (Straughan 1983). The low intertidal area is typically dominated by polychaetes and nemerteans (Straughan 1983).

Subtidal Zone (Soft Bottom Habitats)

In general, Monterey Bay supports a highly diverse and abundant array of benthic infauna (biota that live in the sediments) and epifauna (biota that reside on the substrate). Typically, the soft bottom epifaunal and infaunal assemblages in the nearshore and offshore regions are highly variable and can depend on depth, sediment type, nutrients, dissolved oxygen levels, temperature, and turbidity (Battelle 1990). Yet broad trends in species distribution and composition persist. The highest soft bottom species densities occur in the nearshore shelf habitat and decline between the shelf and upper slopes, remaining relatively constant on the mid-slope, and slightly increasing on the deep slope and basin in this region (Battelle 1990).

Nearshore shelf [<30 meters (100 feet)] soft bottom infaunal assemblages are predominantly composed of polychaetes, amphipods and molluscs. The polychaete (marine worm) fauna in this habitat is largely composed of deposit feeders and carnivores, yet relatively few filter feeders. The lack of abundance of filter feeders may be an indication that the near bottom water is turbid with resuspended sediments to a level that would interfere with the ability of filter feeding polychaetes to persist in higher numbers. Soft bottom epifaunal assemblages in the nearshore shelf consist predominantly of crustaceans, polychaetes, and echinoderms. The distribution and abundance of these species varies seasonally and these changes tend to shift with the oceanographic seasons.

The soft bottom infaunal assemblage associated with the offshore shelf [49-147 meters (160-483 feet)] habitat is composed of ophiuroids, polychaetes, sipunculids, crustaceans, gastropods, and bivalves (Battelle 1990). The upper slope [209-221 meters (685-727 feet)] is dominated by crustaceans, polychaetes, echinoderms, bivalves, and gastropods (Batelle 1990). Infaunal species composition on the slope between 201 meters (660 feet) and 314 meters (1,030 feet), described as the “northern upper slope,” is dominated by crustaceans, bivalves, and polychaetes. In some regions, the lower end of this depth range [274-396 meters

(900-1300 feet)], described as the "mid-slope," assemblage is dominated by gastropods, ostracods, and polychaetes. The deep slope [305-951 meters (1,000-3,120 feet)] has relatively low species density and varies in composition but is dominated primarily by polychaetes, bivalves, and amphipods.

Hard Bottom Habitats

Hydrographic surveys conducted for the project identified rock outcrops in the vicinity of the cable route. These were found in deeper waters. The features were found to be of low relief and silt covered. Associated fauna typically includes anemone, *Metridium farcimen*; cup coral, *Paracyathus stearnsi;* sea cucumber, *Parastichopus* spp.*;* sea star, *Stylasterias forreri;* and species of rockfish.

Pelagic Zone

The open water, or pelagic zone, consists of the entire water column from the air-sea interface to the sea bottom. As the depth of water increases in this zone, light, temperature, and dissolved oxygen decrease, while pressure increases. Oceanic waters up to depths of approximately 200 meters (656 feet) are referred to as the epipelagic zone. These waters are well lit, well mixed, and support photosynthetic algal communities. Water from 200 to 1,000 meters (656-3,280 feet) deep is referred to as the mesopelagic zone. The area below 1,000 meters (3,280 feet) is referred to as the bathypelagic zone, which is characterized by complete darkness, low temperature, low oxygen concentrations, and high pressure.

Fish species distribution is heavily governed by the environmental factors characteristic to the zones listed above; they can be described according to zonation. Demersal fish are those that live on or near the seafloor. Representative species common to Central California are summarized in Table 8-1.

Pelagic fish, those associated with the ocean surface or water column, can also be described according to depth zonation. The distribution of pelagic fish is extensive and incorporates much of coastal California. Pelagic species common to the area are grouped according to depth zone and summarized in Table 8-2.

Table 8-1 Depth Distribution of Demersal Fish Common to Central California

Water Depth			
50 - 200 m (66-656 ft)	200 - 500 m (656-1640 ft)	500 - 1,200 m (1640-3936 ft)	1,200 - 3,200 m (3936-10496 ft)
Sanddabs *Citharichthys sordidus*	Sablefish *Anoplopoma fimbria*	Thornyheads *Sebastolobus* spp.	Rattails *Coryphaenoides* spp.
English sole *Parophrys vetulus*	Pacific hake *Merluccius productus*	Pacific hake *Merluccius productus*	Thornyheads *Sebastolobus* spp.
Rex sole *Glyptocephalus zachirus*	Slickhead *Alepocephalus tenebrosus*	Slickhead *Alepocephalus tenebrosus*	Finescale codling *Antimora microlepis*
Rockfish *Sebastes* spp.	Eelpouts *Lycodes* spp.	Rattails *Coryphaenoides* spp.	Eelpouts *Lycodes* spp.

Table 8-1 Depth Distribution of Demersal Fish Common to Central California

Water Depth			
50 - 200 m (66-656 ft)	200 - 500 m (656-1640 ft)	500 - 1,200 m (1640-3936 ft)	1,200 - 3,200 m (3936-10496 ft)
Pink surfperch *Zalembius rosaceus*	Rockfish *Sebastes* spp.		
Plainfin midshipman *Porichthys notatus*	Thornyheads *Sebastolobus* spp.		
White croakers *Genyonemus lineatus*			

Source: Morro Group 1999.

Table 8-2 Depth Distribution of Pelagic Fish Common to Central California

Epipalagic Fish <200 m (61 ft)	Mesopelagic Fish 200-1,000 m (61-305 ft)	Bathypelagic Fish >1,000 m (305 ft)
Mackerel (*Scomber japonicus*)	Black smelt (*Bathylagus milleri*)	Dragonfish (*Idiacanthidae* ssp.)
Salmon (*Onchorhyncus* spp.)	Viperfish (*Chauliodontidae* ssp.)	Hatchetfish (*Sternoptychidae* ssp.)
Pacific herring (*Clupea pallasii*)	Lanternfish (*Myctophidae* ssp.)	Bristlemouth (*Gonostomatidae* ssp.)
Northern anchovy (*Engraulis mordax*)		
Rockfish *(Sebastes* spp.)		
Medusafish (*Icichthys lockingtoni*)		
Pacific sardine (*Sardinops sagax*)		
Pacific saury (*Cololabis saira*)		
Pacific argentines (*Argentina sialis*)		
Tuna (*Thunnus* spp.)		
Blue shark (*Prionace glauca*)		
Sevengill shark (*Notorhyncus cepedianus*)		
Sixgill shark (*Hexanchus griseus*)		

Source: Bence et al. 1992; ARPA 1995; Ferguson and Cailliet 1990; Cross and Allen 1993